

ON THE CHINESE LAC INSECT.

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Before 1923 all lac insects were placed in one genus, *Tachardia*. In that year, a paper by me (1) separated them, from a physiological standpoint, into genuine and pseudo-lac insects, while Chamberlin (2), on morphological grounds, independently came to the identical conclusion. However, the species which produce commercial lac have not been given the specific designations they deserve and with regard to them Chamberlin has radically (3) differed from me. Lac insects, like the honey bee, occur wild as well as are domesticated. I have recently (4) shown that at least one species of lac insect, *Lakshadia communis*, has, up to now, never been cultivated and attempts to do so have invariably resulted in total failure. This species is the same which has been studied by Garcia da Horta, at Goa, in 1563; by Roxburg, at Samulcotta on the Coromandal Coast, in 1790; by Carter, at Bombay, in 1861; and by Tachard, in Madras, in 1740 so that their observations alone support one another.

Green received lac insects from different localities all over the continent of India. With such a heterogeneous material different lac insects were misinterpreted as one species but with an extremely polymorphic nature. Green's specimens were passed on to Chamberlin who took the mixed type material as homogeneous and naturally threw more shadow than light upon the problem. One insect which has been positively misinterpreted by him is *Lakshadia chinensis* about which Chamberlin (3) pronounces, «It is quite impossible to speculate safely as to the real identity of this species». Yet he has unwittingly confirmed its identity when he has described, what he considered to be a new spe-

cies, named by him *L. rangoonensis*. Its «lac is light reddish orange in colour», as he gives it which is specific of *L. chinensis*. Systematists, in ignorance of the biology of their insects, have

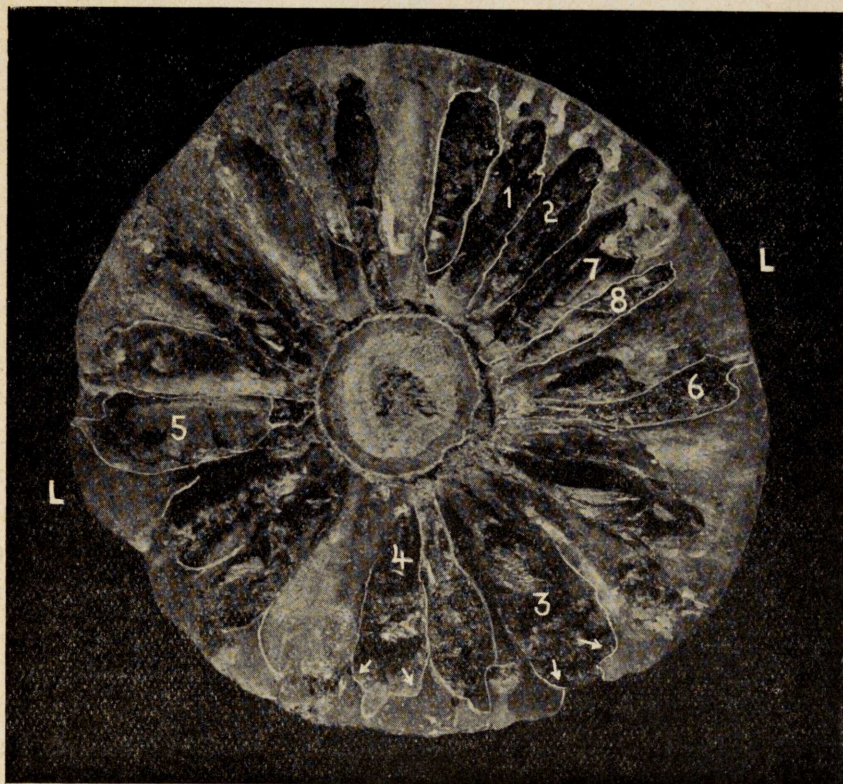


Fig. 1.—*Lakshadia chinensis*, fresh encrustation, on a *Ficus* sp. Nowgong, Assam, seen in transverse section. Pure lac secreted at L. Insects with short Brachial Tubercles, Nos. 1 and 2 with supplementary wax tubes connecting them with the surface of the encrustation. Insects Nos. 3, 4 and 7 are larger than the rest.

(Magnification 37:10.)

described males and females as belonging to different genera. A similar mistake explains the creation of the species, *L. rangoonensis*. When the larva of a winged male lac insect changes its sex, such an adult female builds a cell, larger than the normal and which further looks crown-shaped, as distinct from the typical spherical one. Such a crown-shaped cell of *L. chinensis* has become the new species, *L. rangoonensis*, of Chamberlin. This interpretation is liable to confirmation. Whereas stick lac of

L. chinensis can be had in tons it is impossible to get even an ounce of material belonging to *L. rangoonensis*. Secondly the

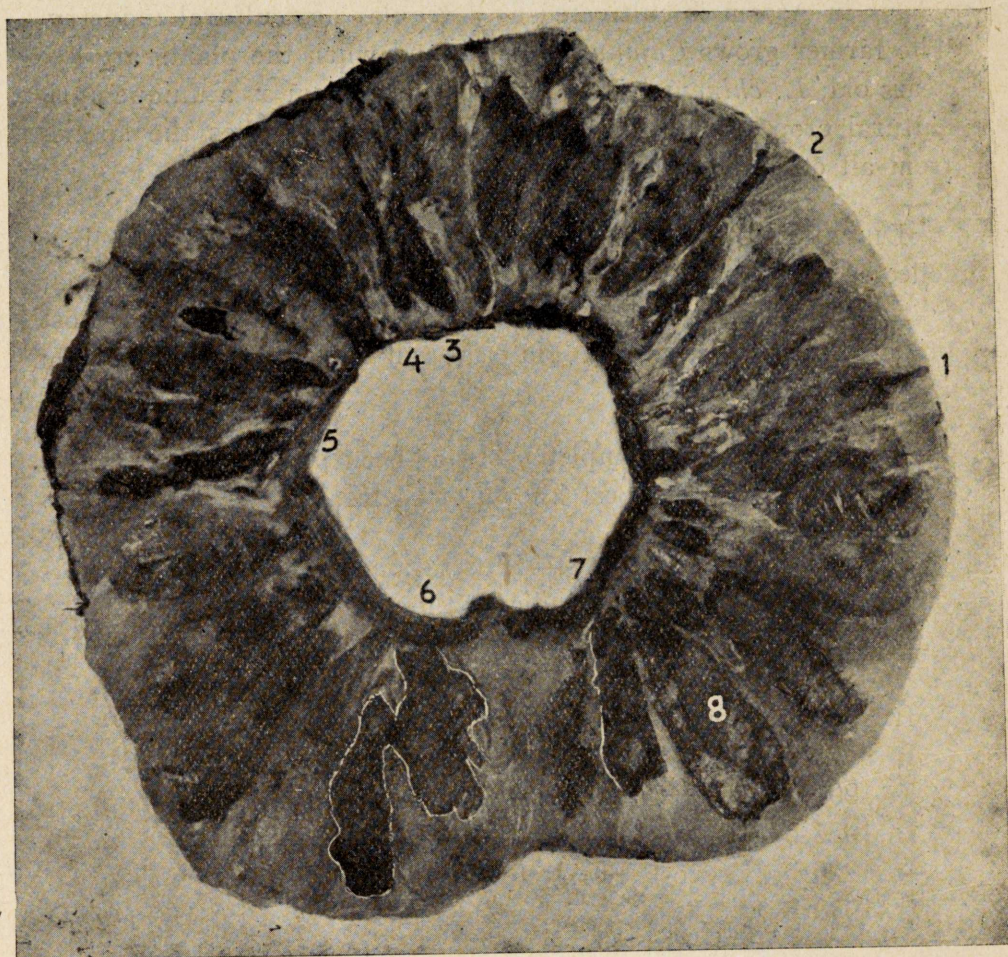


Fig. 2.—Cross section of fresh stick lac of *L. chinensis* from the same source as Fig. 1. Insect No. 1 has a long Anal Tubercle and also No. 2. Insects Nos. 2, 3 and 4 are highly elongated. Insect No. 7 is deep in the interior and was connected with long wax tubes faintly seen in the picture. Object No. 6 shows two insects cut near each other, such forms typical of *L. chinensis* are also seen in Fig. 3. Insect No. 8 is ideal. (Magnification 37:10.)

gregarious lac insects form large colonies, sometimes one encrustation may have 1,000 individuals. It can be said, without fear of contradiction, that not even three cells of *L. rangoonensis* will be found forming a common piece of encrustation. These crown

shaped cells are rare and occur singly; I have seen two only in a few cases, but never three cells together.

In contrast to *L. communis* which is a wild species, *L. chinensis* in Assam is cultivated as a regular agricultural industry. The farmer grows *Cajanus indicus* and when the plants are two years old, *L. chinensis* is propagated upon them as a unique agricultural crop. Even this fact radically distinguishes the species from all other lac insects.

DISTRIBUTION.—*Lakshadia chinensis* is cultivated as well as collected. It is found in the valleys of Bhutan, in Assam, Burma, Siam and Indochina. The lac insect in Yunnan, China, is most probably the same species. Material can be had in pounds from any host plant.

HOST PLANTS.—A complete list has been previously (5) given. *Cajanus indicus* is the best known of them all.

PREVIOUS ILLUSTRATIONS.—Illustrations appearing in the following communications all indicate the same species.

In 1760 by Ledermüller, See Reference (6). Fig. «h».

In 1863 by v. Gernet, See Reference (7). Fig. 4.

In 1880 by Comstock, See Reference (8). Fig. 2. Plate 19.

In 1893 by Tozzetti, See Reference (9). Fig. 12, p. 106.

In 1901 by Newstead, See Reference (10). Fig. 1. Plate A.

In 1925 by Chamberlin, See Reference (3). Fig. 1 B on p. 35.

In 1926 by Crevost, See Reference (11). Figure on p. 72.

In 1930 by A. B. Misra, See Reference (12). Fig. 1 C and D and fig. 2 D on p. 161.

In 1931 by Mahdihassan, See Reference (13). Fig. 1, plate 13; fig. 1, p. 166 and fig. 3, p. 167.

In 1936 by Mahdihassan, See Reference (14). Figs. 1 and 2 on p. 205.

In 1937 by Mahdihassan, See Reference (15). Fig. 2, p. 529; figure 11, p. 544.

In 1941 by B. E. Read, See Reference (18) p. 39 the illustration showing stick lac longitudinal section.

TYPES IN MUSEUMS.—In the National Museum at Prague a show case contained stick lac which belongs to *L. chinensis*. The

collection of coccids in the Natural History Museum, Berlin, contained specimens all of this species. Likewise Zoological Museum in Copenhagen possesses a specimen which the late Dr. Henriksen kindly spared in part and proved to be *L. chinensis*. The

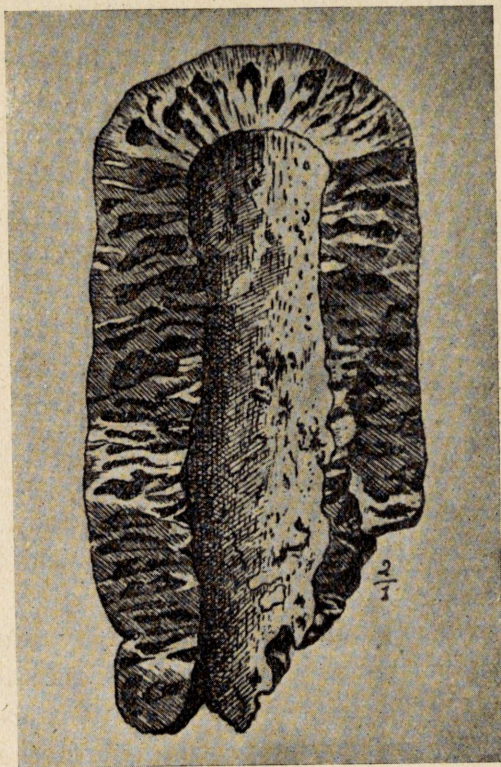


Fig. 3—*Lakshadia chinensis* from Indochina illustrated by Crevost, a typical encrustation of this species as seen in section. (Magnification 2:1.)

Natural History Branch of the British Museum has Lac encrustations labelled «From Siam (formerly deposited at the), East India Museum» which Mr. Laing partly gave me. There is also lac from Siam collected by Dr. A. Günther. Both these specimens belong to *L. chinensis*. My thanks are due to Mr. Laing for the gift.

Misra describes six new species of lac insects without indicating their *range of distribution* and one is in doubt where stick lac belonging to them can be had. His species, *L. longispina* and

L. kydia, have been illustrated both with the same long spine and appear to me identical with each other. They further appear identical with my *L. chinensis* where the Spinoid Tubercle shows variation within the range indicated in Misra's illustrations.

Plurality among lac insects has been indirectly recognised by the trade which further makes other subtle differences depending upon host plant and on the season of the year. One of the earliest writers to have pronounced such a judgement and to have enlightened the reader with illustrations was Swagerman (16). In 1780, he recognised three sorts of stick lac, correctly mentioning them according to their *wide range of distribution*, from Siam, from the Coromandal Coast and from Bengal, rather than from Bangkok, Masulipatam or Calcutta respectively. He considers

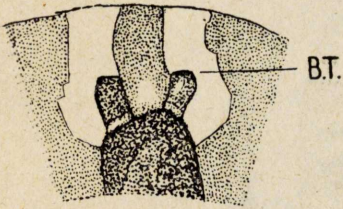


Fig. 4.—Insect No. 1, in Fig. 1 partly enlarged to show the white wax tubes and the short Brachial Tubercles, B. T.

Siam lac the best of them all. To Swagerman and his contemporaries best lac was that which gave the highest yield of lac dye. The rich dye content specifies material belonging to *L. chinensis*; the other two sorts of stick lac mentioned by him are inferior.

The larvae of lac insects fix themselves once for all at spots where they ultimately develop into mature females. It is easy to show the density of population per unit surface of a twig colonised by lac insects. *L. communis* has been found to show the thinnest population even in the larval stage. By statical method and by photographs this phenomenon can be illustrated. As soon as growth begins competition for food shows a sudden rise in death rate. Population is reduced early and competition minimised from the very outset; subsequently death occurs in a relatively small percentage. The fully developed colony or fresh stick lac shows insects so separated from one another that their number can be easily counted by examining groups of three white dots on the surface of lac encrustation, for each group represents an insect hidden beneath. The space dividing individual insects may be even so great that they may occasionally form isolated cells. Both these phenomena have been previously (15) illustrated (fig. 3 A; Lk and L, p. 530).

L. chinensis, is the very opposite of *L. communis* as its colonisation is most dense of all lac insects. Individuals die gradually showing that they are able to resist competition for food. They mostly die when competition for food is the severest, when the bodies are fully grown but eggs are not mature. A section of its fresh stick lac invariably shows dead individuals at a relatively mature stage. This deferred death rate is probably due to its better ability to draw food which would also explain how *L. chinensis* is able to attack thick stems, while a typical lac insect feeds only on thin shoots. Fresh stick lac of *L. chinensis* thus incorporates normal living insects as well as dead full grown individuals but with eggs not fully formed.

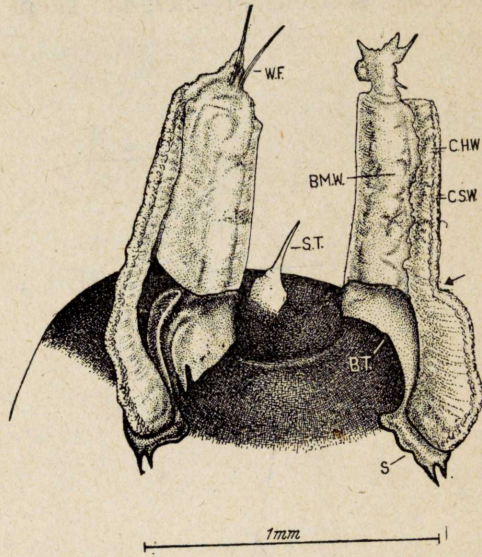


Fig. 5.—Another insect with short Branchial Tubercles and with wax tubes associated with them; for comparison with Insect No. 1, Fig. 1.

Lac dye is found only within the body of the insect. Living insects yield it best but, commercially dead and dry material is invariably used. But when lac is collected so late that the larvae have swarmed away, the bodies of such dead mothers contain very little dye, and such lac is of little value. Formerly when lac was propagated for its dye content a calculated quantity of fresh stick lac was reserved as brood-lac for propagating the insect while the main crop was cut prematurely. Weight for weight stick lac of different sorts even when collected wild, showed that of *L. chinensis* contains the largest number of premature dead insects a fact not mentioned in the literature but upon which the reputation of Siam and other commercial sorts depended. When collected prematurely and dried properly stick lac of *L. chinensis* was naturally even more superior to the rest, for the bodies of this insect have the largest total volume per unit weight of

stick lac. It means, on comparing individual insects of different species, *L. chinensis* would appear to have the greatest body volume.

Lac insects grow at right angles to the long axis of the twig ; in cross sections of stick lac their bodies appear radically arran-

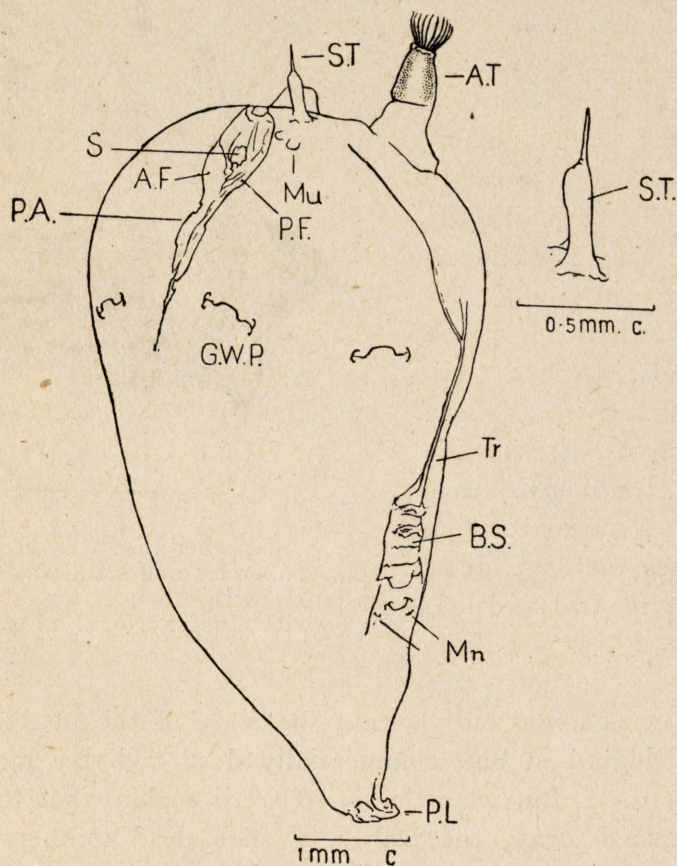


Fig. 6 —*Lakshadia chinensis*, from Indochina, on a *Dipterocarpus* tree, with a typical broad and flat surface on the anal end of the insect ; for comparison with insects No. 5, Fig. 1 and No. 8, Fig. 2.

ged, separated from one another as by spokes of a wheel. Such pictures, showing differences between *L. communis* (fig. 4, p. 75) and *L. nagoliensis* (fig. 6, p. 76), have been already (17) published. The same method when applied to *L. chinensis* brings out its own special features. Fig. 1 is a cross section of fresh

lac of *L. chinensis* on a *Ficus* sp. growing during the monsoons at Nowgong, Assam. Insects marked Nos. 1, 2 and 8 are radially arranged, while No. 6 is less, being pressed by its neighbours has come to acquire a curved body. Insect No. 1 is elliptical, while No. 3 has a broad end towards the periphery or towards the anal end of the body, where arrows are marked to show a broad flat surface of the body. The arrow to our right shows a sharp curve of the body thus indicating the anal surface must be very flat indeed. Comparing insects Nos. 1 and 3 the former appears elliptical, the latter rectangular, indicating a large body-volume of a typical Chinese lac insect. Such «rectangular» insects have been illustrated by Comstock (8) in his longitudinal section of stick lac and are represented here by insects Nos. 3, 4 and 7 in fig. 1. In fig. 1, insect No. 4 is also indicated with arrows to show a similar broad surface at the insect's anal end. The cell show its Anal opening has been cut oblique. Cell No. 5 shows the Anal opening of the cell in an almost ideal condition. The shape of this cell is typical of *L. chinensis*; lac cell No. 5 in fig. 1 should be compared with the insect, fig. 6, shown later on. Fig. 1 shows copious secretion of lac in places marked with L. This character is absent in *L. communis* while it is still more pronounced in *L. nagoliensis* as has been illustrated (17) before.

Fig. 2 is derived from the same material as fig. 1 but the stem was thicker which got detached while sectioning; and it may be mentioned again that with *L. chinensis* material this detachment¹ usually occurs. Here insect No. 1 is conspicuous by its long and thin Anal Tubercle. Insect No. 2 shows the Anal Tubercle almost

¹ Recently in the *Ann. Ent. Soc. America*, 1947, vol. 40, p. 604. I have quoted Hautefeuille the French lac expert of Indo-china who clearly noted this property with stick lac there. It appears to have been observed even as early as 1563, by the Portugese physician and writer, Garcia da Horta, in his well known book, *Discurses on Herbs*, printed in Goa. Garcia says «In Pegu (Burma) there is lacre on the sticks (i. e. stick-lac)... this gum is deposited on sticks and twigs as bees do honey... (stick-lac) is laid in the shade until the sticks is withered and a tube of lacre is left and sometimes stick remains» Now this is possible only with stick-lac of *Lakshadia chinensis* which is also found in Pegu. Garcia, who made more intimate observations on the Indian lac insect, *L. communis*, does make any such remark with the Indian material.

like a thread. This feature is characteristic of *L. chinensis* as has been also illustrated (7) by v. Gernet (fig. 4 CC). Insect No. 2 hardly looks like an insect; towards its left, one of the Brachial

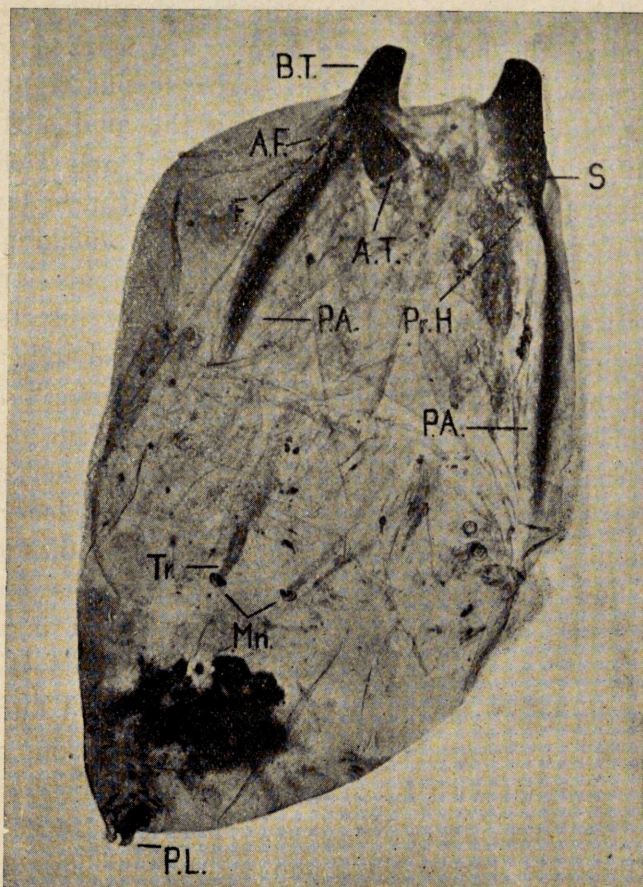


Fig. 7.—*Lakshadia chinensis*, from Indochina, with long rib like chitinisation associated with the Brachial Tubercle and proceeding downwards, Parastigmatic Appendages, P. A., found only in this species, but not in all individuals even of the same colony.

Tubercles, below the surface of stick lac, is seen like a short stump surrounded by a tube wax which connects the major spiracle with the atmosphere. Insects Nos. 3 and 4 also give the impression that they are not insects. Similar elongated bodies have been shown by Comstock in his section of stick lac. Insect

No. 5 is not fixed radially but distinctly inclined and further it falls short of reaching the external surface of the encrustation. Insect No. 7 is even further removed from the exterior but such a stump like body of a lac insect has been already illustrated (7) by v. Gernet (fig. 4 C). Insect No. 8 is ideal with *L. chinensis* and compares with fig. 6.

When insects grow inclined towards each other or partly intertwined and a section is taken of such an encrustation it may show basal part of one insect and the frontal portion of another. When they lie close to each other these two halves in section might appear as belonging to the same individual. The result would be a bizarre form of a hypothetical monster. Where No. 6 stands two insects have been cut showing such a union. Such curious shapes are seen only with material where population is dense and as belonging to *L. chinensis*. An identical representation has been offered in Crevost's picture, reproduced here as fig. 3. It is again without any adhering stick; the insects are deeply set within the encrustation and not connected with the external surface, none is oval shaped, or elliptical, or with a flat upper surface, or quadrilateral as in fig. 1. Fig. 2 fails to give a distinct shape of most of the insects except cell No. 8; fig. 3 does the same, which shows a specific section of stick lac belonging to *L. chinensis*.

Fig. 1, insect No. 1, shows Brachial Tubercles with white wax tubes ending at surface of the encrustation. Fig. 4 shows the Brachial Tubercles further enlarged. Brachial Tubercles, B. T., fall short of reaching the surface of the encrustation. The white portion shows the tubes of wax connecting the spiracles with the associated cell openings on the surface of stick lac. Figure 5 shows still further enlarged a similar insect with its Brachial Tubercles and associated wax arising from the spiracles, S, and leading to the exterior which is not shown here. Fig. 1, insect Nos. 1 and 2 gives photographic evidence supporting illustrations such as fig. 5 here and the fact that in *L. chinensis*, the Brachial Tubercles may be so short as not to reach the surface of the encrustation. Insect No. 1, in fig. 1, shows a bent in the wax tube; this spot is indicated in fig. 5 with an arrow. Such a bent is absent on the left wax tube in insect No. 1, fig. 1 and also in fig. 5, which is another insect but of the same spe-

cies. The point must be emphasized that in *L. chinensis* the Brachial Tubercles are small and the insect supplements them with wax tubes just mentioned and with these supplementary means

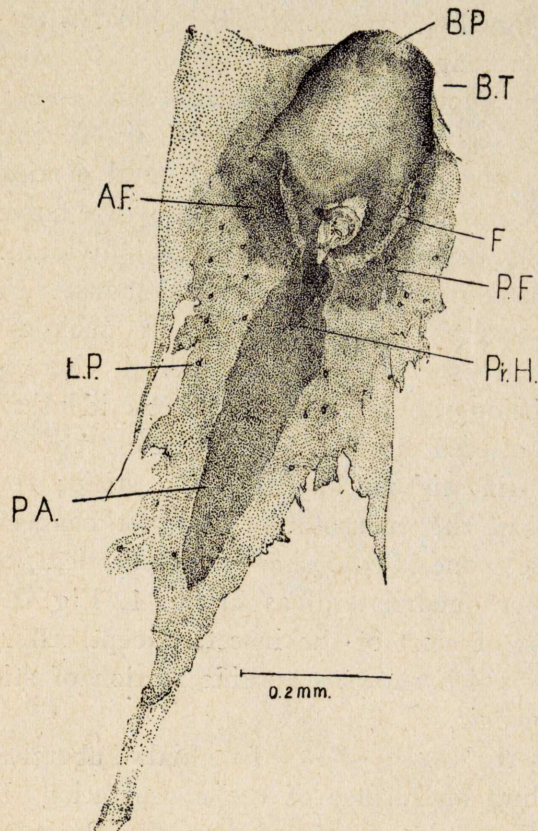


Fig. 8.—*Lakshadia chinensis*, from Indochina, showing Parastigmatic Appendage in greater detail, the Brachial Tubercle shown belongs to the left side of the insect.

it gets a connection with the outside atmosphere. In comparison *L. nagoliensis* has large Brachial Tubercles.

Another reason for *L. chinensis* being rich in lac dye is its voluminous body. Fig. 1, insect No. 5, and fig. 2, insect No. 8, were mentioned as good representatives in this respect. A similar insect is shown in fig. 6. It was growing on a *Dipterocarpus* tree in Indochina during the monsoon season. The broad flat surface towards the insect's anal end is very apparent. On the ventral posterior surface the body segments, B. S., are seen as ves-

tiges along with the Minor spiracles, Mn. Trachae, Tr., associated with the Minor spiracles, are also shown. The body segments, seen here clearly and also illustrated by Tozzetti (9) are not so visible with other species. The Brachial Tubercle, incorporating the Major Spiracle, S., shows a continuation of chitinisation along the path where, in pseudolac insect, parastigmatic pores are situated; I have called this chitinisation Parastigmatic Appendage, P. A. At the base of the Brachial Tubercle, towards the anterior side, there is the broader area of chitinisation called here Anterior Flap, A. F., with the corresponding Posterior Flap, P. F., which relatively is smaller in breadth. A long Spinoid Tubercle is almost always present and is distinctive of this species. It may be a very long spine as Misra (12) has illustrated it, but more usually the structure is a spine resting on a blunt dome like tubercle, the Spinoid Tubercle, S. T., seen also separately and more enlarged in fig. 6. Although lac insects from Siam, Burma and other regions have been studied by others, it is surprising how they escaped noticing the parastigmatic chitinisation, P. A. I have thought it worth while supplementing fig. 6 by a

photograph, fig. 7, which is also derived from a specimen coming from Indochina. The Spinoid Tubercle here has been intentionally removed to bring the Brachial Tubercles into prominence. The parastigmatic Appendages, P. A., are self-evident. I imagine that this chitinisation helps to keep the voluminous insect bodies rather firm against pressure from their neighbours. Near the Spiracle, S., and below it is the Peritreme Hook, Pr. H.; presumably the place where muscles are attached. On the left,

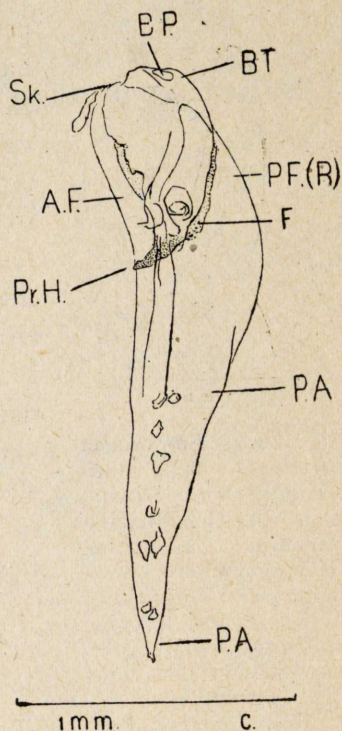


Fig. 9.—*Lakshadia chinensis*, from Indochina, showing the Brachial Tubercle on the right side of an insect, with a prominent Parastigmatic Appendage and a short Brachial Tubercle.

near to the Anterior Flap, A. F., there is a line of thin chitination, a Furrow, F., presumably the area from where Hard Wax arises and forms an envelope along the Brachial Tubercle. This has been explained formerly (15) at some length.

Since this is the first time the chitinised Parastigmatic Appendage is being mentioned in detail fig. 8

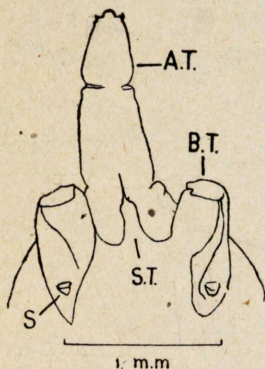


Fig. 10. — *Lakshadia chinensis*, type material from Siam, kept in the British Museum of Natural History, with a characteristic long Anal Tubercle and a typical Spinoid Tubercle, also short Brachial Tubercles.

has been added. It would appear that Misra (12) in his specimen, *L. longispina*, fig. 1 C, also found such a Parastigmatic Appendage, but he attaches no importance to it and does not even mention its existence. In his illustration there is a continuous chitination below the Spiracle. The chitination in Misra's specimen is gradually thinning which is quite possible but usually the chitination broadens at first and then terminates at a point. Fig. 8, shows how below the spiracle the chitination is thin and then broadens, where the Peritreme Hook, Pr. H., is seen while further downwards it immediately broadens and finally thins down where Parastigmatic Appendage, P. A., is indicated. Fig. 8 shows a typical short Brachial Tubercle, B. T., of *L. chinensis* with the associated

structures of the left side of an insect.

Fig. 9 shows a Parastigmatic Appendage of the right side marked in places, P. A. The Peritreme Hook, Pr. H., is conspicuous below the Spiracle which is not marked. On either side of the Spiracle, separated by Furrows, F., are seen the Anterior Flap and the Posterior Flap of the right side, P. F. (R.). Uppermost is seen the margin of the skin, Sk., with a faintly raised or short Brachial Tubercle, B. T. Fig. 9 shows a short Brachial Tubercle, while fig. 7, a relatively longer one; but both have come from the same biological source, as did also fig. 8. This is mentioned to indicate its polymorphism.

In explaining fig. 2, it was mentioned that the Anal Tubercle is exceptionally long in insects Nos. 1 and 2. Tozzetti (9) has given a somewhat large Anal Tubercle but nothing extraordi-

ry. Fig. 10 is derived from a portion of the material preserved in the British Museum of Natural History and formerly kept at the East India Museum originally derived from Siam. Such a long Anal Tubercle is found only with *L. chinensis*. The Spinoid Tubercle in the middle, between the two Brachial Tubercles, is also shown as characteristic of this species. The real needle-like spine is set on a relatively blunt knob.

S U M M A R Y

Lakshadia chinensis is the lac insect which gives the best yield of lac dye. Its stick lac contains relatively larger number of dead insects full grown but with immature eggs. This is due to the insect showing a heavy infection with the thickest insect population and deferred death rate. It secretes lac resin fairly copiously but the Brachial Tubercles are short and this defect is supplemented by an exudation of wax tubes which connect the major spiracles with the exterior of the encrustation. The Spinoid Tubercle is often so long as to identify the species. Occasionally the Anal Tubercle is long enough to help the identification. The Brachial Tubercles are very short and there may be extension of chitinisation from them towards the ventral end.

DETAILS OF ABBREVIATIONS IN LETTERING FIGURES

- A. F.—Anterior Flap; a flap like chitinous area at the base of the Brachial Tubercle, facing the Anterior side of the body.
- A. T.—Anal Tubercle.
- B. M. W.—Brachial Marginal Wax, a tube of hard wax from the margin of the Brachial Plate and not from its central wax pores.
- B. P.—Marginal Plate at the top of the Brachial Tubercle.
- B. S.—Body Segment, rudimentary.
- B. T.—Brachial Tubercle.
- C. H. W.—Cavaera Hard Wax, a tube of hard wax from two furrows on each side of the Cavaera.
- C. S. W.—Cavaera Soft Wax, from the pores of glands on the Cavaera or around the Spiracle.
- G. W. P.—Girdle Wax Pores which secrete a hard wax.
- F.—Furrows; long and thin chitinised areas at the base of the Brachial Tubercles from where hard wax arises.

L.—Lac secretion, seen as such.

L. P.—Lac Pores, minute pores which secrete lac resin.

Mu.—Muscle joint on the skin.

Mn.—Minor spiracle.

P. A.—Parastigmatic Appendage, a long rib like chitinisation in the ventral direction of the body from the Spiracle.

P. F.—Posterior Flap; a flap like chitised area at the base of the Brachial Tubercle corresponding to the Anterior Flap but facing the Posterior side of the body.

P. L.—Posterior Lobe, near the Head of the insect.

Pr. H.—Peritreme Hook; the peritreme in which the Spiracle is incorporated ends in a hook like projection to which muscles are probably attached.

S.—The Spiracle, the major spiracle.

S. T.—Spinoid Tubercle.

Sk.—Skin, margin of the skin.

Tr.—Tracheae.

W. F.—Wax Filaments, from pores in the centre of the Brachial Plate.

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